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REPORT FOR CONSULTATION ON THE METROPOLITAN BILLINGS INTRASTATE AIR QUALITY CONTROL REGION (MONTANA)

National Air Pollution Control Administration
Washington, D. C.

August 1970

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ON THE
METROPOLITAN BILLINGS
INTRASTATE AIR QUALITY CONTROL REGION
(MONTANA)

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

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The basic background information is presented for the consultation with state and local authorities prior to the designation of air quality control regions as stipulated in the Clean Air Act. Boundaries for the regions are proposed and the factors which are the basis for the proposed boundaries are discussed. Reports for consultation consider these factors: geography; population and economic activity; their prospective growth; probable direction of physical growth; the emission inventory and the location of sources; air quality and pollution transport analysis; regional planning; air pollution control; and governmental jurisdictions.

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ON THE

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PREFACE

The Clean Air Act, as amended, directs the Secretary of Health, Education, and Welfare to designate "air quality control regions" to provide a basis for the adoption of regional air quality standards and the implementation of those standards. The Act stipulates that the designation of a region shall be preceded by consultation with appropriate State and local authorities. This report is intended to provide the basic background information needed for the consultation. It proposes boundaries for the Metropolitan Billings Intrastate Air Quality Control Region and discusses the factors which are the basis of the proposed boundaries.

The Region* boundaries proposed in this report remain subject to revisions suggested during consultation with State and local authorities. Formal designation of the Region will be made only after a careful review of all opinions and suggestions submitted during the consultation process.

The National Air Pollution Control Administration appreciates assistance received from the State of Montana, the Billings City-County Planning Board, the City of Billings Health Department, and the other agencies and departments that made contributions to this report.

* For the purpose of this report, the word "region", when capitalized, will refer to the Billings Intrastate Air Quality Control Region.

INTRODUCTION

THE REGIONAL APPROACH

Air pollution in the urban areas of the United States is a regional problem which frequently extends across governmental boundaries. Since air pollution problems are rarely confined to any single municipality or county, and are often not confined within a single State, successful control requires coordinated planning, standard setting, and enforcement by the several political jurisdictions which share a common problem. To date, State and local governments across the Nation have only begun to develop a regional approach to air pollution control.

The Clean Air Act, as amended, provides a regional approach which depends upon coordination and cooperation among all levels of government--municipal, county, State, and Federal. To set in motion the machinery for regional air pollution control, the Department of Health, Education, and Welfare designates air quality control regions (following consultation with State and local officials), issues air quality criteria, and publishes reports on control techniques. The designation of region boundaries indicates which State and local jurisdictions will be involved in a regional air pollution control effort. The air quality criteria indicate the extent to which various concentrations of air pollutants are harmful to health and damaging to

property. The reports on control techniques provide information on the costs and effectiveness of various techniques for controlling air pollutant emissions.

After the Department of Health, Education, and Welfare completes these initial steps, State governments develop air quality standards and plans for implementation of such standards within the boundaries of designated air quality control regions. An air quality standard for a region defines the desired limit of concentration of a pollutant in the ambient air. It represents the level of air quality which the regional control program will attempt to achieve. An implementation plan is a blueprint of the steps which will be taken to attain chosen regional air quality standards within a reasonable time. The Clean Air Act requires that within 90 days after the Secretary of Health, Education, and Welfare has designated the region, State Governors must submit letters indicating that they intend to set air quality standards for those pollutants for which criteria and control technology documents have been issued. They have an additional 180 days to set the standards. The procedure for setting standards includes a public hearing which allows residents of a region to express their views concerning the proposed standards. The Governors are required to submit to the Secretary, within an additional 180 days, plans for the implementation of the standards which have been adopted.

The Department of Health, Education, and Welfare reviews air quality standards and implementation plans in order to ascertain their consistency with the provisions of the Act.

When air quality standards and implementation plans are approved, States proceed to prevent and control air pollution in accordance with those standards and plans. This system for establishing a regional approach to air pollution control is outlined in Figure 1.

DESIGNATION OF AIR QUALITY CONTROL REGIONS

Designation of an air quality control region is one of the first steps in the regional approach to air pollution control. Section 107 (a) (2) of the Clean Air Act, as amended, directs the Secretary, Department of Health, Education, and Welfare to make such designations. The portions of the section relevant to this discussion state:

> "...The Secretary, after consultation with appropriate State and local authorities shall...designate air quality control regions based on jurisdictional boundaries, urban-industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards. The Secretary may...revise the designation of such regions...The Secretary shall immediately notify the Governor or Governors of the affected State or States of such designation."

Procedure for Designation of Regions

Figure 2 illustrates the procedures used by the National Air Pollution Control Administration (NAPCA) for designating air quality

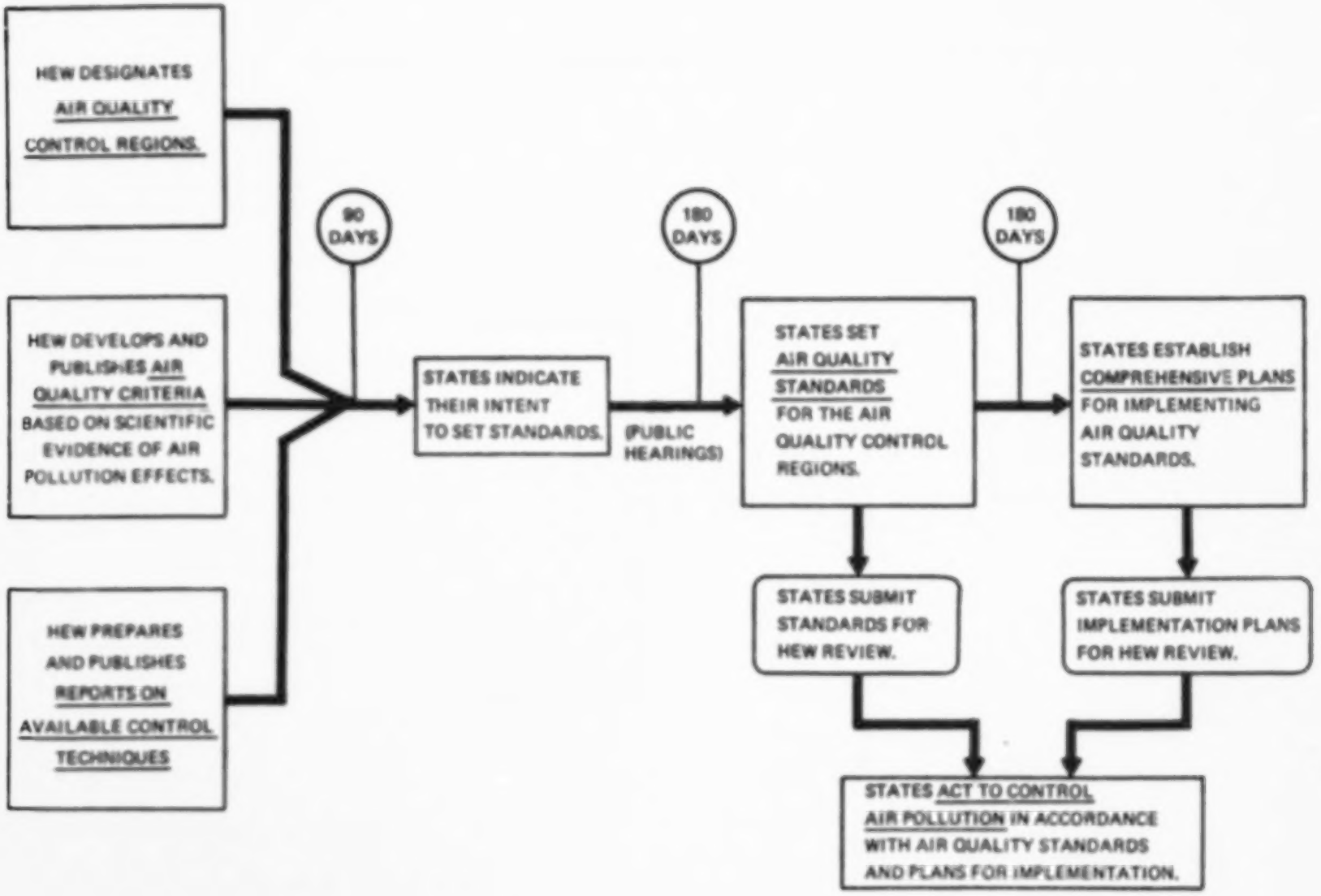
HEW DESIGNATES AIR QUALITY CONTROL REGIONS.
HEW DEVELOPS AND PUBLISHES AIR QUALITY CRITERIA BASED ON SCIENTIFIC EVIDENCE OF AIR POLLUTION EFFECTS.
HEW PREPARES AND PUBLISHES REPORTS ON AVAILABLE CONTROL TECHNIQUES
90 DAYS
STATES INDICATE THEIR INTENT TO SET STANDARDS.
180 DAYS
(PUBLIC HEARINGS)
STATES SET AIR QUALITY STANDARDS FOR THE AIR QUALITY CONTROL REGIONS.
180 DAYS
STATES ESTABLISH COMPREHENSIVE PLANS FOR IMPLEMENTING AIR QUALITY STANDARDS.
STATES SUBMIT STANDARDS FOR HEW REVIEW.
STATES SUBMIT IMPLEMENTATION PLANS FOR HEW REVIEW.
STATES ACT TO CONTROL AIR POLLUTION IN ACCORDANCE WITH AIR QUALITY STANDARDS AND PLANS FOR IMPLEMENTATION.

Figure 1 FLOW DIAGRAM FOR ACTION TO CONTROL AIR POLLUTION ON A REGIONAL BASIS, UNDER THE CLEAN AIR ACT, AS AMENDED.

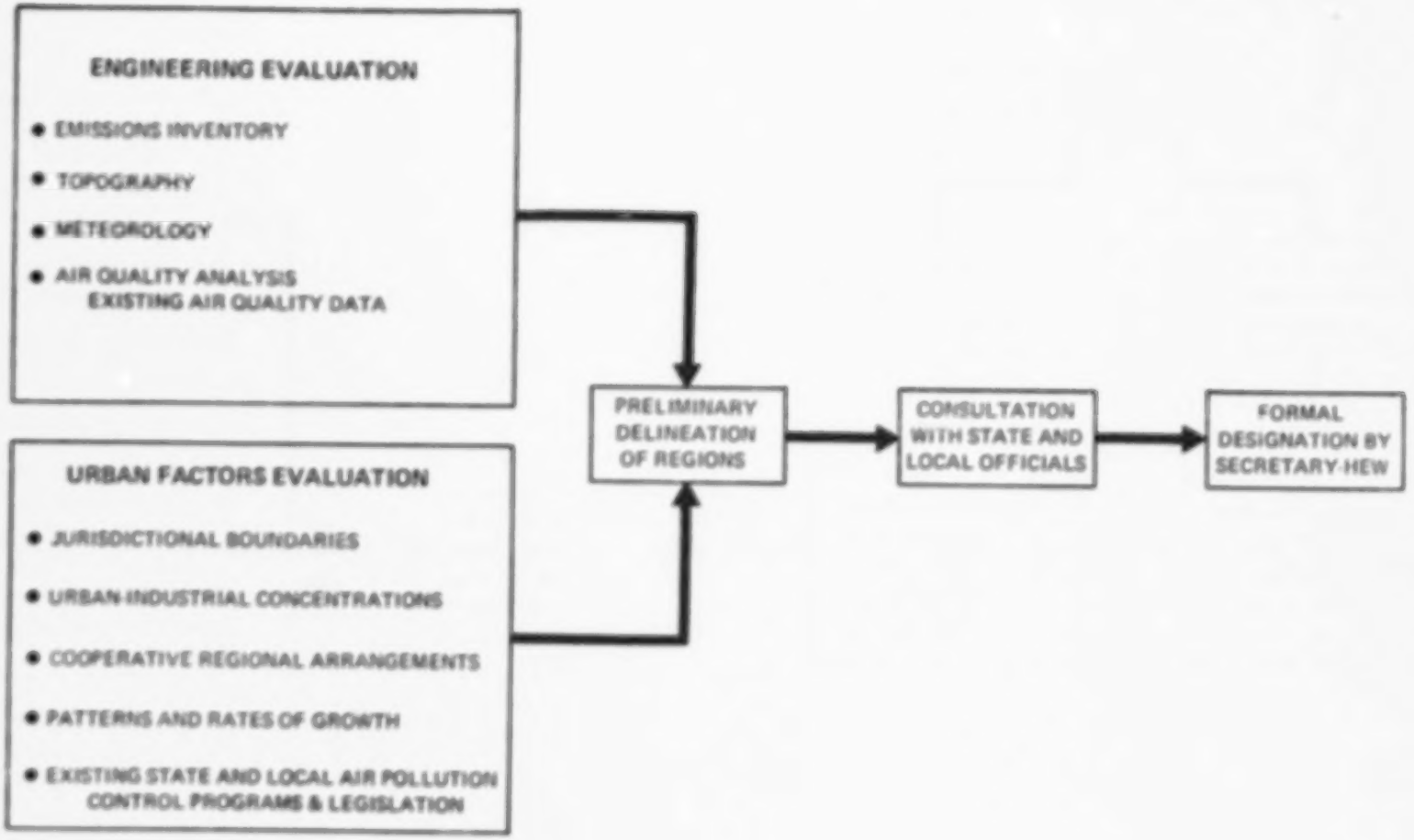
ENGINEERING EVALUATION
• EMISSIONS INVENTORY
• TOPOGRAPHY
• METEOROLOGY
• AIR QUALITY ANALYSIS
EXISTING AIR QUALITY DATA
URBAN FACTORS EVALUATION
• JURISDICTIONAL BOUNDARIES
• URBAN-INDUSTRIAL CONCENTRATIONS
• COOPERATIVE REGIONAL ARRANGEMENTS
• PATTERNS AND RATES OF GROWTH
• EXISTING STATE AND LOCAL AIR POLLUTION CONTROL PROGRAMS & LEGISLATION
PRELIMINARY DELINEATION OF REGIONS
CONSULTATION WITH STATE AND LOCAL OFFICIALS
FORMAL DESIGNATION BY SECRETARY HEW

Figure 2. FLOW DIAGRAM FOR THE DESIGNATION OF AIR QUALITY CONTROL REGIONS

control regions.

After evaluating relevant technical and urban factors in a region, the National Air Pollution Control Administration publishes a proposed delineation of the boundaries. At the same time, NAPCA sets a time and place for a consultation meeting and distributes to State and local authorities a report of the evaluation study (such as this "Report for Consultation") which includes the boundary proposal. At the consultation meeting State and local authorities are encouraged to present fully their views and suggestions concerning the proposed boundaries of the region. Interested parties who do not have official status may submit comments in written form for the record. After careful review of all suggestions and opinions submitted for the record by interested parties, the Secretary of Health, Education, and Welfare makes a formal designation of the region boundaries and notifies the Governor(s) of the State(s) affected by the designation.

The Size of a Region

As stipulated in Section 107 (a) (2), the designation of air quality control regions should be based on "jurisdictional boundaries, urban-industrial concentrations and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards." This language suggests a number of objectives which are important in determining how

large an air quality control region should be. Basically, these objectives can be divided into three separate categories.

First, a region should be self-contained with respect to air pollution sources and receptors. Unfortunately, since air pollutants can travel long distances, it is impractical if not impossible to delineate regions which are completely self-contained. The air over a region will usually have at least trace amounts of pollutants from external sources. During episodic conditions, such contributions from external sources may even reach significant levels. Conversely, air pollution generated within a region and transported out of it can affect external receptors to some degree. It would be impractical and inefficient to make all air quality control regions large enough to encompass these low-level trace effects. The geographic extent of trace effects overestimates the true problem area which should be the focus of air pollution control efforts. Thus, the first objective, that a region be self-contained, becomes a question of relative magnitude and frequency. The dividing line between "important influence" and "trace effect" will be a matter of judgment. The judgment should be based on estimates of the impact a source has upon a region, and the level of pollution to which receptors are subjected. In this respect, annual and seasonal data on pollutant emissions and ambient air concentrations are a better measure of relative

influence than short term data on episodic conditions. In summary, a region should include most of the important sources in the area as well as most of the people and property affected by those sources.

The second general objective requires that regional boundaries be designed to meet not only present conditions but also future conditions. In other words, the region should include areas where industrial and residential expansion are likely to create air pollution problems in the foreseeable future. This objective requires careful consideration of existing metropolitan development plans, expected population growth, and projected industrial expansion. Such considerations should result in the designation of regions which will contain the sources and receptors of regional air pollution for a number of years to come. Of course, regional boundaries need not be permanently fixed, once designated. Boundaries should be reviewed periodically and altered when changing conditions warrant readjustment.

The third objective is that regional boundaries should be compatible with and even foster unified and cooperative governmental administration of the air resource throughout the region. Because air pollution usually extends across governmental boundaries, the cooperation of several governmental bodies is required for the solution of a common set of air pollution problems. In this regard, the established patterns of governmental coopera-

tion on a range of urban problems is an important consideration, and the pattern of cooperation among existing air pollution control programs is a particularly relevant factor. In general, administrative considerations would argue against the division of governmental jurisdictions. Although it would be impractical to preserve State jurisdictions undivided, usually it is possible to preserve the unity of county governments by including or excluding them in their entirety. Occasionally, even this would be impractical due to a county's large size, wide variation in level of development, or striking topographical features.

To the extent that any two of the above three objectives lead to incompatible conclusions concerning region boundaries, the region must represent a reasonable compromise. A region should represent the best way of satisfying the three objectives simultaneously.

As noted above, the evaluations of relevant technical, urban, and governmental factors form the basis of the boundary proposals published by NAPCA. The technical factors study takes account of the location of pollution sources and the geographic extent of serious pollutant concentrations in the ambient air. Pollution sources are identified through an inventory of emissions from power generation, industrial operations, space heating, waste disposal, and other pollution-causing activities. The transport and distribution of pollutants in the ambient air are

analyzed on the basis of measured air quality data, the location of emissions, meteorological data, and topographic information. As a whole, the technical factors study indicates how large the air quality control region should be in order to encompass most pollution sources and most people and property affected by those sources.

The study of urban factors takes account of a different set of considerations. It discusses the location of urban and industrial concentrations and expected patterns of urban growth. As a whole, the urban factors study indicates how large a region should be in order to encompass expected regional growth.

The evaluation of the regional governmental organizations discusses the planning agencies, councils of government, and State and local air pollution control programs. This study attempts to define the combination of counties which, through cooperative regional arrangements, would best work together towards achieving clean air in the region.

The body of this report contains a proposal for the boundaries of the Billings Intrastate Air Quality Control Region, based on the evaluation of technical, urban, and governmental factors. The report is intended to serve as the background document for the Consultation between the National Air Pollution Control Administration and the appropriate State and local authorities.

ENGINEERING FACTORS

Incroduction

A study area for the Billings region is shown in Figures 3 and 4. This includes the counties of Big Horn, Carbon, Golden Valley, Musselshell, Stillwater, Treasure, and Yellowstone.

The engineering evaluation for the Billings area was based on an emissions inventory, a study of topography, meterology, and existing air quality data. The emissions inventory provides information relating to the types and amount of pollutants emitted from each county in the emissions study area.

Meterology

Meterological conditions can have a great effect upon how pollution emitted into the atmosphere will disperse, and as such, can affect ambient air quality where sources exist. For this reason, a study of meteorology is an important part the research leading to the designation of an air quality control region.

Largely, the meteorological conditions of this area are determined by the topographical conditions, as well as location. The fact that the area is entirely east of the continental divide and affected by the "rain shadow" effect, plays an important role in determining the weather in the Region.

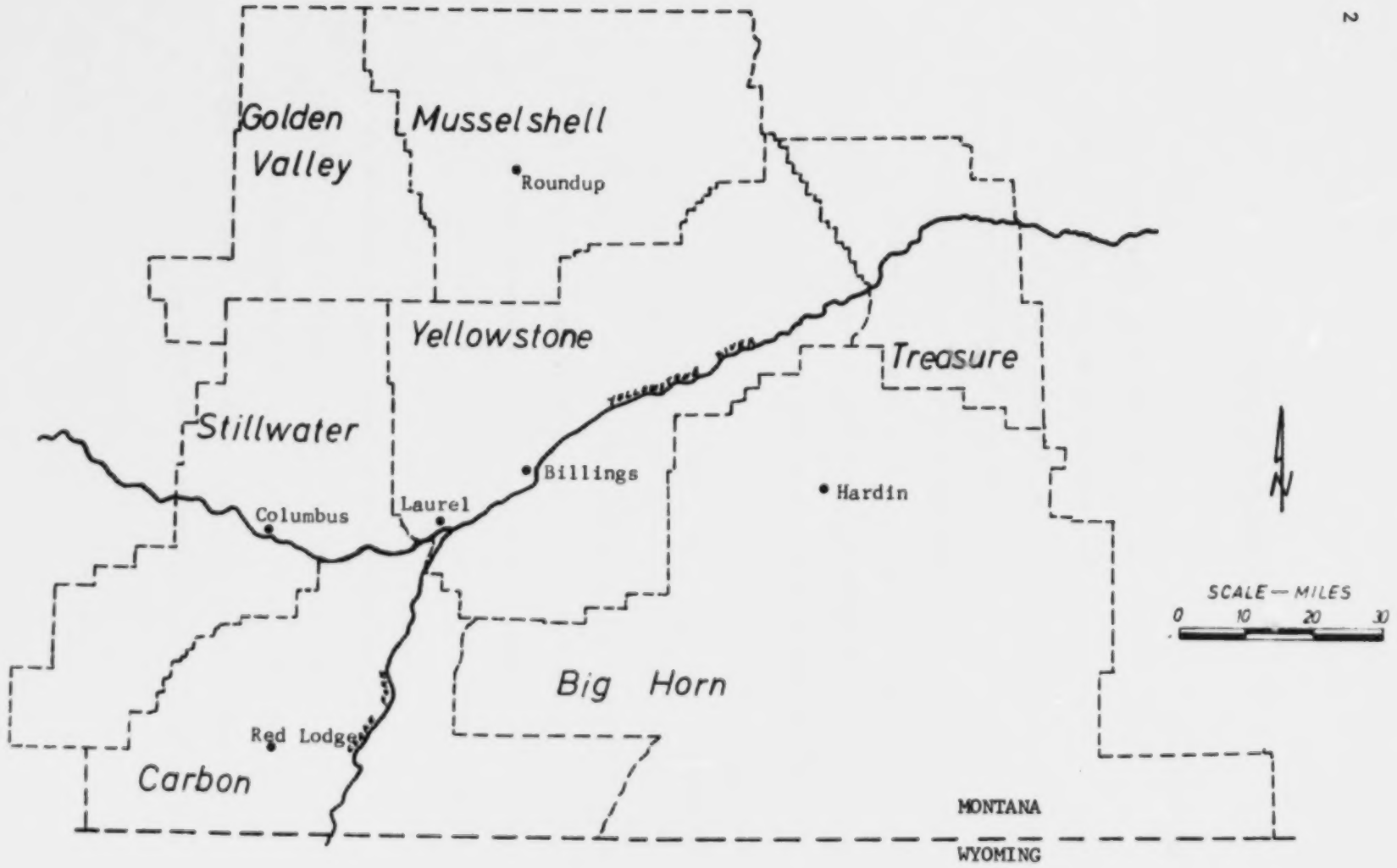

Figure 3. Study Area and Major Cities for Billings Region.

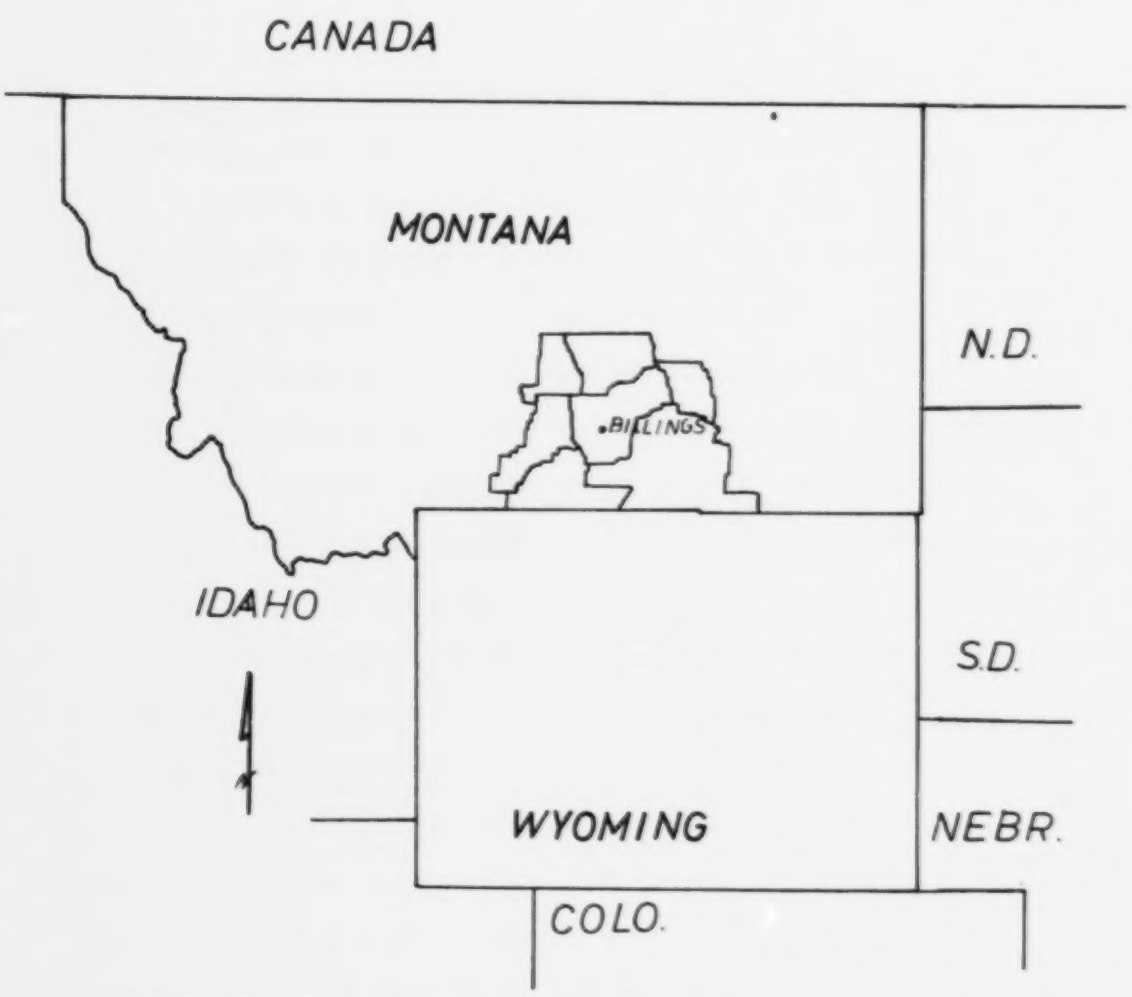

Figure 4. Relationship of Billings Study Area to surrounding areas.

Winters are usually cold, as might be expected. Cool spells are broken now and then by conditions known as "chinook" weather. Chinook weather occurs when warmer air from the Pacific sweeps over the mountains, causing strong winds that may persist for several days. These winds are west-southwesterly and may average 25 to 50 miles per hour or more, depending upon location. Stronger chinook winds occur primarily in the northeastern and eastern slopes of the continental divide. Needless to say, these winds would have a great effect upon pollution causing the dispersion of pollutants over a wide area from local sources, or conversely, diluting the concentration close to a source.

Summers are mild, with spells of warm weather. Summer nights are cool, so the heat never becomes oppressive. At elevations above 4,000 feet, hot weather is almost unknown.

Winds occur mainly from the southwest, as they are throughout the year, except during the spring, when they come from the northeast. Wind speeds average 11-12 miles per hour throughout the year. Wind roses for Billings are shown in Figure 5.

Often, when high valley walls restrict the cross-currents of air flow, there results a condition known as "channeling." Channeling causes the movement of the atmosphere to be restricted inside the valley walls and consequently a higher concentration of pollutants would be experienced within these areas than one where the air is free to disperse in all directions. Also,

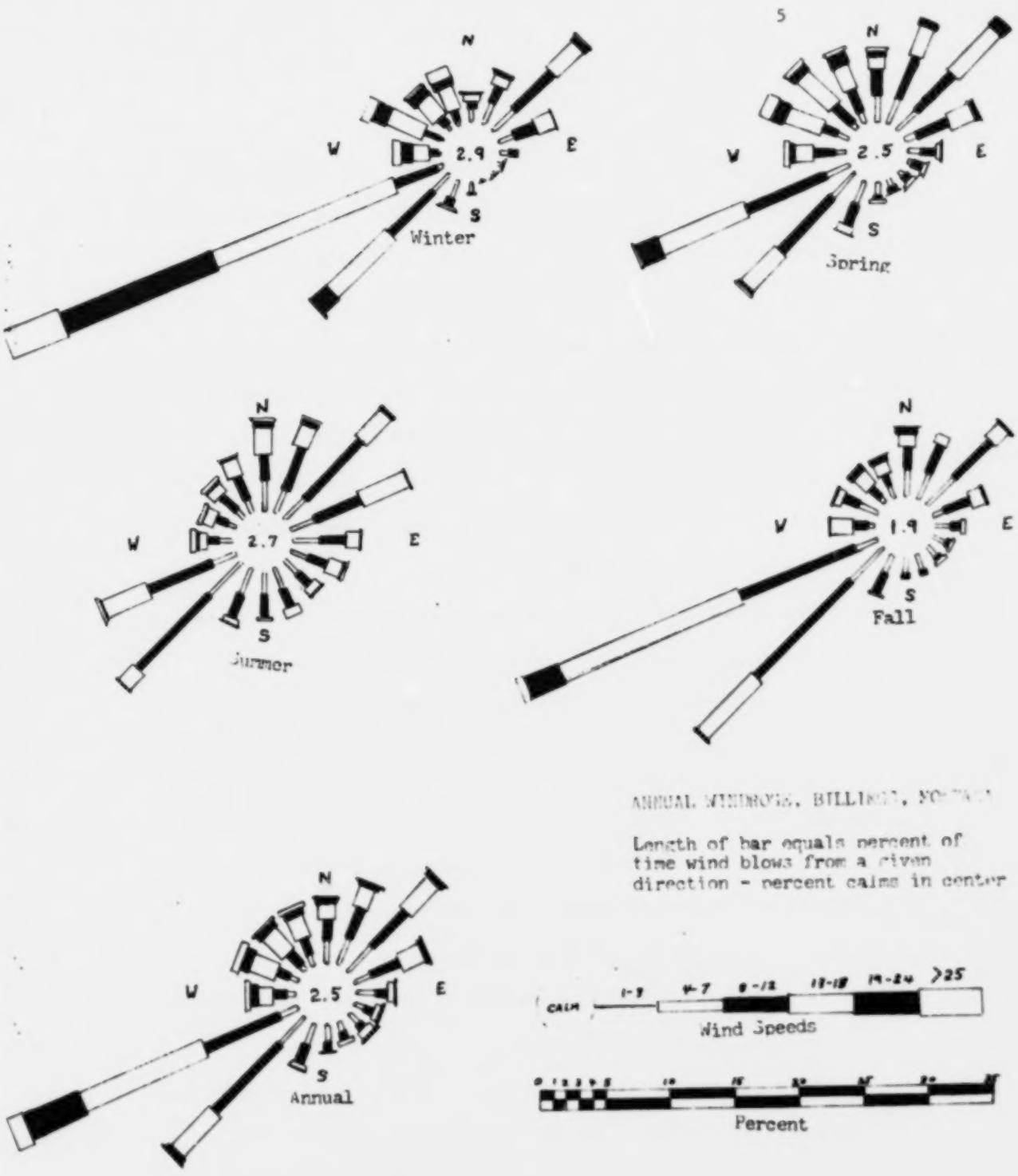

FIGURE 5. WINDROSES FOR BILLINGS

SOURCE: U. S. PUBLIC HEALTH SERVICE

channeling causes pollution to affect more distant places since the dispersion is less. The channeling of pollutants down the valley regions would be a factor affecting pollution in this region.

Inversion frequency, as an annual occurrence, is about 40 - 45 per cent. During the winter, this rises to between 50 and 55 per cent. In the summer, it is between 30 and 35 per cent, and the fall between 45 and 50 per cent. Atmospheric inversions restrict the dispersion of pollutants and enhance the buildup of pollutants near ground level.

Mixing depths for Billings are given in Table I. Mixing depths provide a measure of the volume within which pollutants may mix without restriction. Mixing depths are lowest in the morning, and seasonally, during winters.

Topography

A study of topography is an essential part of an examination of factors concerning the dispersion of pollutants in the atmosphere. Topographical conditions can enhance or restrict movements of the atmosphere, but cannot be reflected completely in a meteorological discussion only.

The developed portion of the study area is dominated by the Yellowstone River Valley. The Yellowstone River runs across Stillwater County in an eastward direction, where it joins numerous

TABLE I.
BILLINGS, MONTANA
MIXING DEPTHS (METERS)

	WINTER	SUMMER	ANNUAL
Morning	250	340	325
Afternoon	700	3,000	1,925
Average	475	1,670	1,125

feeder streams such as Sweetgrass, Boulder, Stillwater, and Clark Fork. Many of the major cities of the study area are located on or close to these streams, such as Billings, Laurel, Columbus, and Forsyth. Many of these streams and rivers are subject to flooding in the spring and early summer. This results from ice breaking up as well as spring rainstorms. Local rainstorms also present a flash flood potential.

The topography varies greatly as one goes from east to west across the study area. In Treasure County, the terrain is much leveler than that further to the west. Actually, the study area lies in the foothills, where the Rockies rise up from the floor of the Great Plains. Elevations to the west are more than 3,000 feet above elevations in the east, and for points in the Custer National Forest Area, much higher than that.

In Yellowstone and Treasure counties the land around major population centers is generally rolling, surrounded on the sides by the valley walls of the Yellowstone River. Away from the valley, the hills grow steeper and more rugged.

The central city of Billings is located at an elevation of about 3,300 feet on relatively flat land. Around this city, the land will play a dominant role in deciding the direction of future growth. To the north of the city a cliff called the Rimrocks, extend about five miles across the most highly developed areas.

They vary from 200 to 500 feet above the lower valley heights. A similar ridge runs across the southeastern portion of the Billings area. To a certain extent, then, these ridges will limit the growth of Billings to the land adjacent to the river. The Yellowstone winds through the two converging cliffs.

The counties of Musselshell and Golden Valley also lie in an area that can be characterized as the beginning of the Rockies. There is no valley system in these counties to break the ranges of mountains and hills. Elevations throughout the area range around 4,000 feet, and higher, getting much higher toward the northwest. The southern part of Musselshell County, south of Roundup, is primarily forests.

The topography of Big Horn County is principally that of rugged hills with several streams that feed into the Little Big Horn and Big Horn Rivers. The Yellowtail Dam on the Big Horn River just west of Old Fort Smith has created a large reservoir and recreation area on the boundary between Carbon and Big Horn Counties. The Wolf and Rosebud Mountains on the southeast side of the county rise to he ghts above 5,000 feet and run in a northeast to southwest direction.

Carbon and Stillwater Counties both have valley regions similar to Yellowstone County. The Yellowstone River flows through Stillwater County, but the valley gets narrower and the valley walls steeper the further west one goes. In Carbon County,

the Clark Fork created a similar valley region that extends north and south through the middle of the county. Elevations in Carbon County range from around 4,000 feet to much higher. Granite Peak, the highest point in Montana, is just over the county line from Carbon County in Parke County, and it rises to a height of approximately 12,800 feet. Generally, elevations in Custer National Forest, in the southwestern section of the county, are much higher than the rest of the county. In Stillwater County, elevations are higher in the southern section of the county, in the area covered by the national forest.

Emissions Inventory

The National Air Pollution Control Administration, Division of Air Quality and Emissions Data, in conjunction with the Billings County Health Department, has completed an emissions inventory of Yellowstone, Carbon, and Stillwater Counties. The survey area is shown in Figure 6. The complete report will appear in a separate publication, and only county summaries will be presented here.

The Public Health Service rapid survey technique was used for the estimation of pollutant emissions. Using this system, individual quantities of pollutants were estimated for point sources, and area wide for all other sources.

Table II lists the summary totals for the entire survey area. Sulfur oxides resulted mainly from fuel combustion in industry and power plants, and industrial processes. Particulate emissions

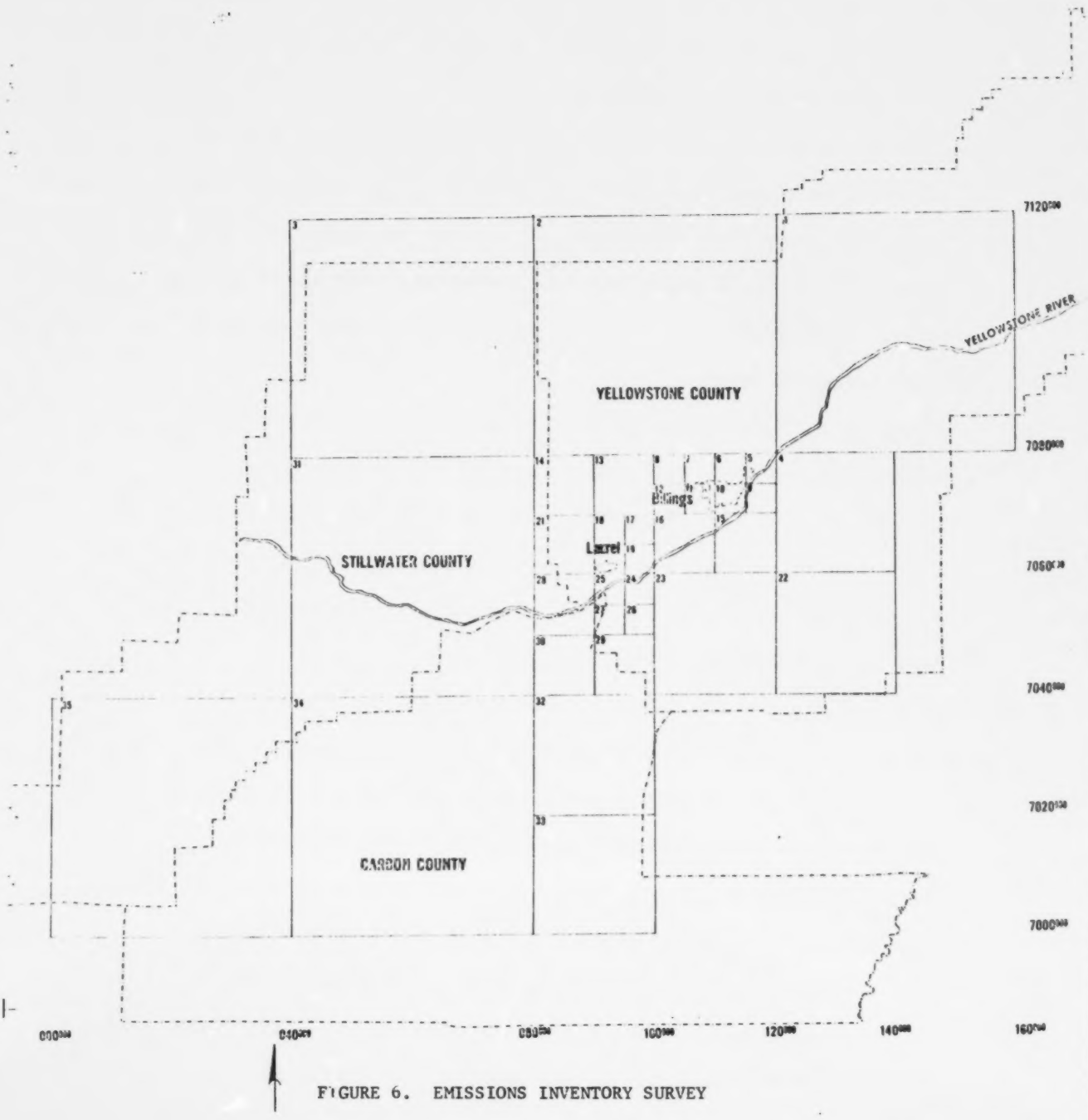

FIGURE 6. EMISSIONS INVENTORY SURVEY

resulted largely from industrial processes, and to a lesser degree from fuel combustion and transportation. Carbon monoxide emissions came almost equally from transportation and industrial processes. About half of the hydrocarbons were emitted from industrial processes, with about 30% coming from transportation and lesser amounts from evaporation. Nitrogen oxide emissions resulted from almost all sources to a great degree, with no particular source prevailing. Transportation and fuel combustion contributed almost equally to nitrogen oxides, while industrial processes contribute slightly lesser amounts.

Tables III, IV, and V list the emissions for the counties separately for Carbon, Stillwater, and Yellowstone, respectively. In Carbon and Stillwater Counties, the major pollutant emissions come from refuse disposal and transportation, rather than industrial processes or combustion of fuels. Open burning accounts for a large part of the emissions in both counties.

In Yellowstone County, combustion of fuels and industrial processes accounted for large amounts of the pollutants emitted, which points out the industrialization in this county. Sulfur oxides emissions came mainly from industrial combustion of fuels (30%), steam-electric power plants and industrial processes (53%). Seventy-eight per cent of the particulates came from processes, with smaller amounts from fuel combustion and transportation. Processes accounted for over half of the hydrocarbons, with transportation submitting a little over one fourth of the total.

TABLE III

SUMMARY OF AIR POLLUTANT EMISSIONS
IN CARBON COUNTY
TONS/YEAR

SOURCE CATEGORY	SULFUR OXIDES	PARTICULATES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
TRANSPORTATION					
Road Vehicles	9	15	1,101	101	113
Other	30	84	46	104	171
Sub-Total	40	100	1,147	206	284
COMBUSTION OF FUELS					
Industry	0	0	0	0	0
Steam-Electric	0	0	0	0	0
Residential	12	6	22	4	21
Comm. and Inst.	7	4	15	3	15
Sub-Total	20	10	38	7	37
REFUSE DISPOSAL					
Incineration	0	3	14	0	0
Open Burning	0	34	186	65	26
Agric. Burn.	0	103	604	121	12
Sub-Total	0	140	804	186	38
PROCESS	0	0	0	0	0
EVAP. LOSSES	0	0	183	0	0
GRAND TOTAL	60	250	1,989	582	359

TABLE II

SUMMARY OF AIR POLLUTANT EMISSIONS
IN STUDY AREA
TONS/YEAR

SOURCE CATEGORY	SULFUR OXIDES	PARTICULATES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
TRANSPORTATION					
Road Vehicles	277	463	45,347	3,821	3,372
Other	311	1,164	8,726	2,769	2,300
Sub-Total	589	1,627	54,074	6,590	5,673
COMBUSTION OF FUELS					
Industry	7,424	386	25	56	2,131
Steam-Electric	3,500	1,052	81	36	3,308
Residential	43	53	61	13	278
Comm. and Inst.	27	35	42	8	182
Sub-Total	10,994	1,526	209	113	5,899
REFUSE DISPOSAL					
Incineration	23	9	252	11	47
Open Burning	0	61	330	115	46
Agric. Burn.	0	289	1,701	330	34
Sub-Total	23	359	2,283	465	127
PROCESS	13,170	10,841	57,625	12,558	4,734
EVAP. LOSSES	0	0	0	3,921	0
GRAND TOTAL	24,776	14,353	114,191	23,647	16,433

TABLE IV

SUMMARY OF AIR POLLUTANT EMISSIONS
IN STILLWATER COUNTY
TONS/YEAR

SOURCE CATEGORY	SULFUR OXIDES	PARTICULATES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
TRANSPORTATION					
Road Vehicles	14	25	1,733	160	182
Other	31	85	46	106	173
Sub-Total	46	110	1,780	266	355
COMBUSTION OF FUELS					
Industry	0	0	0	0	0
Steam-Electric	0	0	0	0	0
Residential	11	4	18	4	13
Comm. and Inst.	7	3	12	2	12
Sub-Total	19	8	31	6	26
REFUSE DISPOSAL					
Incineration	0	1	7	0	0
Open Burning	0	22	120	42	17
Agric. Burn.	0	125	738	148	15
Sub-Total	0	148	865	190	32
PROCESS	0	0	0	0	0
EVAP. LOSSES	0	0	0	215	0
GRAND TOTAL	66	266	2,679	677	413

TABLE V

SUMMARY OF AIR POLLUTANT EMISSIONS
IN YELLOWSTONE COUNTY
TONS/YEAR

SOURCE CATEGORY	SULFUR OXIDES	PARTICULATES	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES
TRANSPORTATION					
Road Vehicles	253	422	42,512	3,559	3,077
Other	249	993	8,633	2,558	1,956
Sub-Total	502	1,416	51,146	6,117	5,033
COMBUSTION OF FUELS					
Industry	7,423	386	25	56	2,131
Steam-Electric	3,500	1,052	81	36	3,308
Residential	19	43	20	4	243
Comm. and Inst.	12	27	13	2	153
Sub-Total	10,954	1,508	139	98	5,835
REFUSE DISPOSAL					
Incineration	22	4	229	11	45
Open Burning	0	4	24	8	3
Agric. Burn.	0	61	358	71	7
Sub-Total	22	69	611	90	55
PROCESS	13,170	10,841	57,625	12,558	4,734
EVAP. LOSSES	0	0	0	3,521	0
GRAND TOTAL	24,648	13,834	109,521	22,384	15,657

Evaporation accounted for a smaller portion of the hydrocarbon emissions. Transportation, processes, electric power plants, and industrial burning of fuel all contributed to the emissions of nitrogen oxides.

Air pollution sources in the rural sections of the study area are mainly the result of burning of agricultural residues, garbage, and oil sump wastes. Wind erosion contributes to the suspended particulates as well as dustfall where the soil is not sufficiently protected.

AIR QUALITY

In 1966-67 an extensive study of air pollution in the Billings-Laurel area was conducted by the Montana State Department of Health, Division of Air Pollution Control and Industrial Hygiene. This study represented a cumulation of over 2,800 air quality samples collected during the period 1965 - June, 1967. Ambient air quality levels were surveyed for particulates, tar, arsenic, lead, sulfate, and flouride. Table VI gives the values recorded for these pollutants. The following is a summary of their findings.

Particulates

Contributors to the total suspended particulate matter in the area included burning of all types of trash, garbage, oil, wood waste and the operation of chemical and petroleum plants, the burning of fields, ditches, and pastures, and dust produced on unpaved streets in both cities and the country. Combustion accounted for most of the tar content of the suspended particulates.

Values for suspended particulates ranged from 1 to 490 micrograms per cubic meter of air. Average values generally fell in a range from 60 to 100 micrograms per cubic meter of air.

Dustfall is the particulate matter that is not suspended in the air, but falls out soon after emission. These particles are larger than those encountered in suspended particulate samples, and this type of problem is usually local to a particular source. Sources in the study area included unpaved or dirty streets, combustion without cleaning, other industrial operations, such as petroleum refineries, asphalt and gravel plants. Dustfall in the area averages about .10 tons/square mile/month, with particular stations reporting up to 22 tons/square mile/month, and as low as 5 tons/square mile/month.

Flouride

Almost all flouride pollutant came from the petroleum refineries located at Laurel and Billings. Concentration levels of this pollutant appeared to depend upon proximity to these refineries. Levels varied greatly during the year, with highest levels occurring during February. Most stations reported levels to be around .03 to .04 micrograms per cubic meter of air.

Benzene Soluble Fraction

The benzene soluble fraction of particulate matter is that fraction which is usually referred to as tar. This does not include most of the dust and dirt particles that are not soluble in an

organic solvent. This fraction was found to contain some carcinogenic material. Values ran around 7 and 8 micrograms per cubic meter of air.

Lead

Lead pollution results primarily from vehicle exhausts. Concentrations measured in the Billings area averaged from .13 micrograms per cubic meter of air to .51, depending upon location.

Suspended Sulfate

Levels of suspended sulfate in the air indicated that this is a problem here. On several occasions, the concentration exceeded 12 micrograms per cubic meter of air. There appeared to be a general abundance of sulfur compounds in the air sampled, as the values for the reactive sulfur will indicate.

Particulate Flourides

Levels of particulate flourides were monitored for three months during the study. Values generally ran in the neighborhood of .04 - .06 micrograms per cubic meter of air.

Reactive Sulfur

Reactive sulfur levels tended to vary greatly with sampling point. Values ranged from about 1.5 milligrams $SO_3/100cm^2/day$ to 0.2 milligrams $SO_3/100cm^2/day$. Most of the samples fell in the range from 0.4 to 0.5.

TABLE VI 1/

Station	Period	No. of Samples	Total Susp. Particulate			Benzene Soluble Fraction			Concentration of Specific Pollutants in Micrograms Per Cubic Meter of Air: Arsenic			Lead			Sulfate			Fluoride		
			Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.
L.S.	66-67	Year	80	171	21	75	36	2	7	.10	0	.01	.77	.01	.16	24	4	8	.12	.01	.07
	66-67	Dec.-Feb.	25	150	26	79	16	3	7	.10	0	.01	.28	.04	.13	22	2	9	.04	.04	.04
	1967	Mar.-May	22	145	21	61	15	2	7	Discontinued			Discontinued			26	3	7	Discontinued		
	1967	June-Aug.	9	79	21	46	6	2	3	Discontinued			Discontinued			9	4	6	Discontinued		
	1966	Sept.-Nov.	21	171	27	91	36	3	8	.08	0	.01	.77	.01	.20	24	0	9	.12	.01	.05
[illegible]	66-67	Year	78	242	9	69	15	1	6	.14	0	.02	.63	0	.23	35	0	6			.03
	66-67		26	146	9	56	12	1	6	.02	0	.01	.63	0	.31	31	0	7	.01	.01	.01
	1,67		23	140	17	65	11	2	5	Discontinued			Discontinued			35	2	7	Discontinued		
	1967		7	121	19	46	7	1	5	Discontinued			Discontinued			10	2	4	Discontinued		
	1966		22	242	12	97	15	3	7	.14	0	.01	.55	0	.21	27	2	6	.09	.01	.04
E. B.	66-67	Year	83	402	4	70	42	1	6	.01	0	.01	1.28	0	.39	25	0	6	.06	.01	.04
	66-67		31	161	14	67	13	2	6	.01	0	.01	1.28	.06	.51	18	2	6	.06	.06	.06
	[illegible]		26	402	8	65	42	1	6	Discontinued						25	1	6	Discontinued		
	1967		9	58	4	28	6	2	3	Discontinued						6	1	2	Discontinued		
	1966		22	260	27	73	13	2	7	.01	0	.01	1.28	0	.35	23	0	6	.05	.01	.03
E.S.	66-67	Year	89	182	6	67	19	2	5	.07	0	.01	1.75	.02	.42			8	.03	.01	.02
	[illegible]		28	119	6	174	19	2	6	.01	0	.01	.75	.07	.39	30	2	9	.01	.01	.01
	1967		26	150	21	64	11	2	4	Discontinued			Discontinued			37	2	7	Discontinued		
	1967		7	64	22	38	5	2	3	Discontinued			Discontinued			5	1	3	Discontinued		
	1966		23	182	25	74	16	3	6	.07	0	.01	1.75	.02	.28	59	2	8	.03	.01	.02
C. H.	66-67	Year	70	350	14	100	33	1	10												
	1966	June-Aug.	16	126	61	201	20	1	8												
	1966	Sept.-Nov.	8	303	23	110	31	5	17												
	66-67	Dec.-Feb.	16	350	14	106	22	1	12												
	1967	Mar.-May	30	284	27	96	19	2	6												
B.C.	66-67	Year	63	356	1	60	34		10												
	1966	June-Aug.	10	67	1	27	8		3												
	1966	Sept.-Nov.	9	185	22	68	33	2	11												
	66-67	Dec.-Feb.	19	356	6	80	20	1	5												
	1967	Mar.-May	25	99	10	47	7	1	3												
[illegible]	66-67	Year	107	326	2	82	16	1	5												
	1966	June-Aug.	21	128	45	81	9	1	6												
	1966	Sept.-Nov.	14	214	45	123	18	2	9												
	66-67	Dec.-Feb.	28	326	22	84	15	1	5												
	1967	Mar.-May	39	236	2	81	12	1	5												

*L.S. - Lockwood School

S.S. - Starrett School

B.E. - Billings Airport

C.H. - City Hall

[illegible]

1/ Montana State Department of Health. A study of Air Pollution in the Laurel-Billings Area 1966 - 1967.

URBAN FACTORS

POPULATION

The problem of air pollution can be directly related to the occurrence of industrial and urban development. Not only are people the prime receptors of air pollution, they are the initiators of the problem. By studying population statistics, projections, and densities, we can get a measurement of the extent of the problem and plan ahead for the future protection of the environment.

County population and densities are shown in Table VII. It can be seen that Yellowstone is by a great amount, the most densely settled county in the study area. However, of Yellowstone's population, approximately 60,549 people live in the central city of Billings. This leaves a population density, outside of Billings, of approximately 10 persons/square mile. Other major cities in the study area are Laurel, with a 1970 population of 4,412; Hardin, with a population of 2,758; Roundup, with a population of 2,072; Red Lodge, with a population of 1,811; and Columbus, with a population of 1,173. The location of these cities is shown on the map in Figure 3. Outside of Billings, the population distribution is decidedly rural. Where river valleys dominate the topography, the greatest population densities tend to occur in the river valleys. This is due largely to the more abundance of useable land located near the rivers, as well as the proximity to cheap transportation.

If present trends continue, the movement of people from the farms to the cities will further decrease the population densities

in the outlying sections of the counties in the study area, resulting in the cities growing in size. Population changes, as shown in Table VII, indicate that this has been the trend in the period 1960-1970. Mechanization, as well as consolidation of farms, should further diminish farm labor jobs, but this should reach a plateau at some point.

The only county showing substantial growth in the period 1960-1970 is Yellowstone, and almost all of this growth can be attributed to urbanization around the city of Billings.

INDUSTRIAL AND ECONOMIC INDICATORS

The location of manufacturing and other economic activity is useful in determining the boundaries for an air quality control region. Industrial, agricultural, and other economic activities often contribute heavily to air pollution. A discussion of pertinent economic indicators follows.

The industry of the study area is centered in the City of Billings and suburban Billings and Laurel area. Industrial expansion in the 1950's, especially in the petroleum industry, accounts for much of the recent growth of this area.

The Billings Comprehensive Plan, a study developed for the Billings City-County Planning Board, defines the Billings Retail Trade Area as the counties of Yellowstone, Big Horn, Treasure, Musselshell, Golden Valley, Stillwater, and Carbon. This is the area in which retail distribution of goods is primarily centered

in the Billings area. As noted, Billings serves a wide area for trade, and the Billings Wholesale Trade Area, mentioned in the same report, covers a much larger area.

The location of Billings has helped to enhance its position of industrial center for southeastern Montana. Although it is a great distance from many of the large markets, it is well served by rail, air, and ground transportation. Three rail lines, three airlines, and 81 motor freight carriers supply the bulk of transportation for Billings.

When completed, Interstate 90 will connect Billings with points to the west, such as Bozeman, Butte, and Missoula, and a portion will also connect with northern Big Horn County, close to Hardin. Figure 6 shows the location of existing and proposed portions of interstates in the study area. In other areas, interstates have served as focal points around which industry and residential settlements grew.

Table VII gives the percent of each county's employment that was engaged in manufacturing occupations in 1960. It is estimated that figures for 1970 would not differ greatly from these. All of the counties in the study area showed minor involvement in industry except Yellowstone, where 11.4% were in manufacturing jobs, and Golden Valley, where there existed no industrial employment. The 1969 estimate of income per household shows that most of the counties in the study area were about on a par using this criteria. Yellowstone County showed the highest value of crops and livestock, with Big Horn County second.

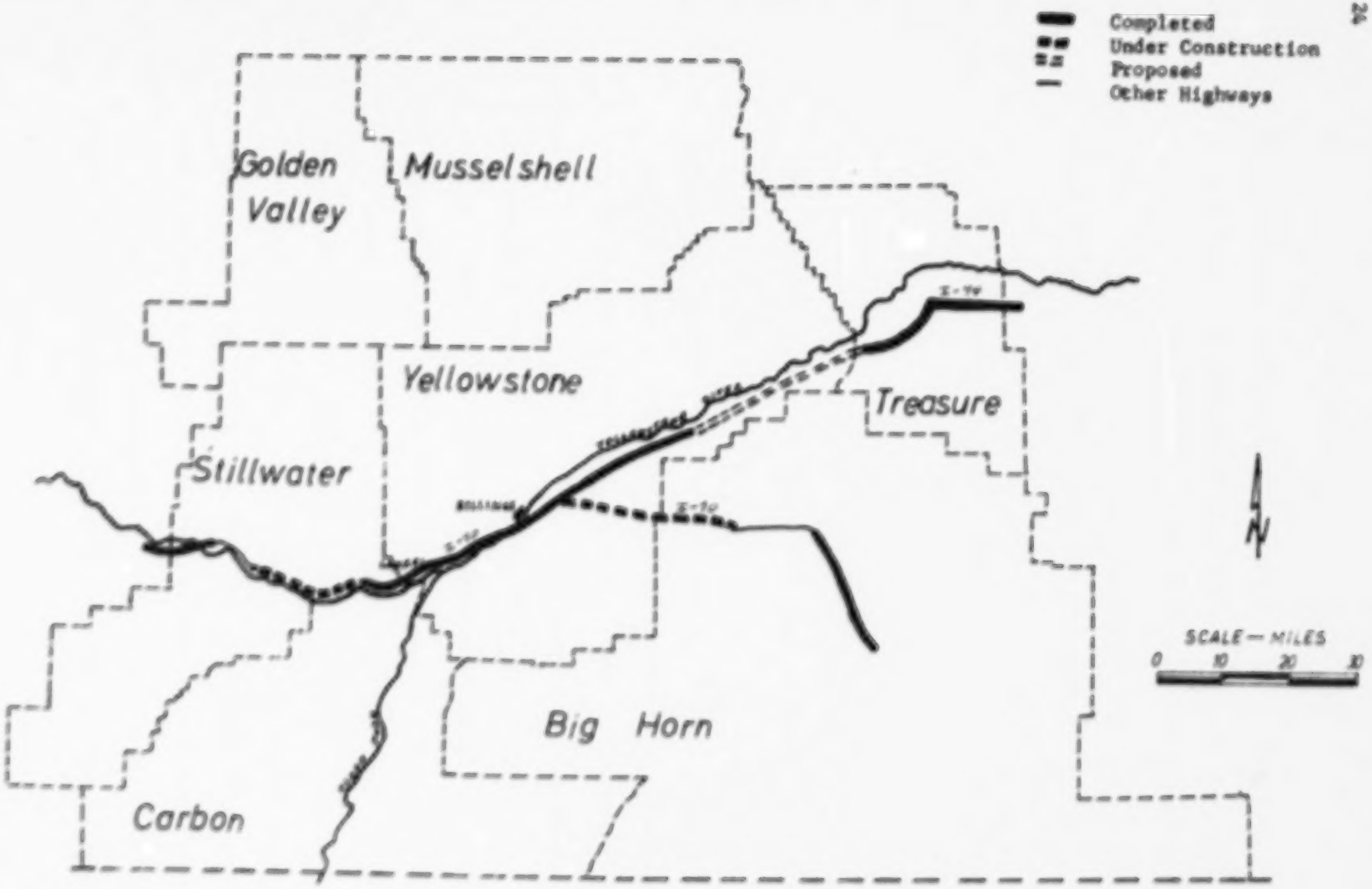

FIGURE 6. INTERSTATE HIGHWAYS IN THE STUDY AREA

TABLE VII

ECONOMIC AND POPULATION DATA FOR BILLINGS STUDY AREA

County	1960 1/ Population	1970 2/ Population	Population Density (1970)	% Emp. Mfg. 1960 3/	Value Added by Mfg. 1963 ($1,000) 2/	1969 Estimate Income Per Household 4/	Number of Farms 4/	Value of Crops and Livestock 4/ ($1,000)
Big Horn	10,007	10,024	1.99	5.6%	+	10,187	588	10,670
Carbon	8,317	6,995	3.38	3.8%	301	9,249	749	8,240
Golden Valley	1,203	906	0.77	*	+	10,254	162	2,470
Musselshell	4,888	3,638	1.93	2%	92	6,907	233	3,122
Stillwater	5,526	4,507	2.51	4.4%	209	8,346	489	6,816
Sweet Grass	3,290	2,862	1.56	2.4%	+	9,885	286	4,355
Treasure	1,345	1,022	1.04	1.4%	+	10,965	129	2,975
Yellowstone	79,016	86,109	32.6	11.4%	46,270	10,332	1,177	21,956

1/ 1960 U. S. Census
2/ 1970 U. S. Census, Preliminary Reports
3/ 1967 Bureau of Census, County and City Data Book
4/ Editor and Publisher Marketing Guide, 1970 Edition

* Effectively Zero
\+ Not Available

Retail sales are outlined in Table VIII. Food and auto sales accounted for the largest portion of retail sales, with general merchandise and eat and drink stores taking lesser shares. Other retail sales categories listed include lumber and hardware, gasoline, furniture, apparel, and drugs.

Land Use

Land use is of major importance in consideration of air pollution problems. How land is used often will determine if a problem exists, and to what extent.

Table IX gives values for the amount of land in use in four distinct categories: cropland, range and pasture, forest and woodland, and urban and built up. These values are given for the year 1958 and projections for 1975. This will allow us to determine trends in land use in the study area. The percentage totals do not add up to 100% because Federal land was left out of the categories.

Range and pasture land accounted for the largest category of land use items for all the counties in the study area. This reflects the type of terrain and climate that exists in the region, as well as the progress of land development. The fact that there are no substantial increases in the total cropland predicted over the 17 year period covered, indicates that most of the available cropland that can be effectively used is already under cultivation. Nevertheless, cropland increases are shown for 5 of the 8 counties in the study area.

TABLE VIII

RETAIL SALES 1/
($1,000)

County	1969 Estimate (1,000)	Lumber and Hardware	Gen. Mdse.	Food	Auto	Gasoline	Apparel	Furniture	Eat, Drink	Drugs
Big Horn	22,083	3,132	993	5,898	3,708	2,977	893	N.A.	1,818	369
Carbon	11,785	1,503	1,214	2,779	1,443	1,045	491	N.A.	1,385	425
Golden Valley	884	N.A.	N.A.	574	N.A.	N.A.	N.A.	N.A.	125	N.A.
Musselshell	7,161	1,213	N.A.	1,649	1,816	779	N.A.	240	649	N.A.
Stillwater	8,265	1,136	451	1,615	2,686	755	318	N.A.	709	271
Sweet Grass	6,203	882	276	1,105	1,009	1,054	N.A.	N.A.	663	N.A.
Treasure	1,357	551	155	263	N.A.	N.A.	N.A.	N.A.	117	N.A.
Yellowstone	192,939	14,621	20,469	39,912	44,900	14,164	11,561	8,445	16,714	6,980

1/ Editor's Publisher Market Guide - 1969 Edition

TABLE IX 1/

LAND USE (NON-FEDERAL)

County	Year	Total Acreage	Total Cropland	Percent	Total Range and Pasture	Percent	Total Forest and Woodland	Percent	Other	Urban and Built Up	Percent
Big Horn	1958	3,221.1	298.0	9.25	2,667.9	82.8	200.0	6.2	10.8	10.0	.3
	1975		301.1	9.34	2,668.9	82.9	200.3	6.2	10.0		
Carbon	1958	1,324.8	176.8	13.3	543.3	41.0	14.0	1.1	12.8	8.0	.6
	1975		185.7	14.0	548.2	41.4	14.0	1.1	12.7		
Golden Valley	1958	753.9	73.4	9.7	619.8	82.2	13.0	1.7	5.0	7.0	.9
	1975		71.8	9.5	621.9	82.5	12.5	1.7	4.9		
Musselshell	1958	1,207.5	71.5	5.9	750.0	62.1	241.0	20.0	5.9	13.8	1.1
	1975		77.8	6.4	745.1	61.7	239.1	19.8	5.7		
Stillwater	1958	1,150.1	227.1	19.7	610.2	53.1	92.0	8.0	12.3	9.9	.9
	1975		215.1	18.7	622.1	54.1	91.7	8.0	14.8		
Sweet Grass	1958	1,181.4	83.4	7.1	719.7	60.9	57.0	4.8	25.8	7.0	.6
	1975		89.3	7.6	721.4	61.1	57.2	4.8	26.8		
Treasure	1958	629.8	59.4	9.4	528.6	83.9	24.0	3.8	2.1	3.1	.5
	1975		59.0	9.4	531.5	84.3	22.7	3.6	2.1		
Yellowstone	1958	1,686.4	307.8	18.3	1,167.3	69.2	56.0	3.3	20.0	41.0	2.4
	1975		309.7	18.4	1,163.0	69.0	56.0	3.3	20.1		

1/ Montana Soil and Water Conservation Needs Inventory.
Prepared by Montana State Soil and Water Conservation Needs Committee.

The importance of Billings as the industrial and trade center for the area is borne out in the fact that 2.4% of the land area in Yellowstone County was classified as urban and built up, over twice as much as any other county.

Indian Reservations

All of one reservation and part of another are included in the study area. The Crow Reservation is located in Big Horn County and partially in Yellowstone County. The Northern Cheyenne Reservation is located in Big Horn County and Rosebud County. The locations of these reservations is shown in figure 7.

The Crow Reservation covers 2,010,000 acres, and is primarily open grazing land, most of which is leased to non-Indians. The average income is somewhat below that of rural farm families in Montana, but higher than most Indians living on reservations in the State. Most family income is from livestock, land leases, oil and gas leases, and wage labor. Tribal income results principally from oil and gas leases and bonuses, and some from land leases. The Indian population numbers in the neighborhood of 3,000

The Northern Cheyenne Reservation covers 445,000 acres, and is located between the Crow Reservation and Custer National Forest. Two-thirds of the land area is open grazing with timber, and the remainder is farm and waste land. Over half of the land is leased to non-Indians. The land has oil, gas, and coal reserves. The average family income is far below that for all rural farm families in the State. Sources of family income include grazing land and farm land leases, and seasonal wage labor. Tribal income comes mainly from the lease of grazing lands. The Indian population

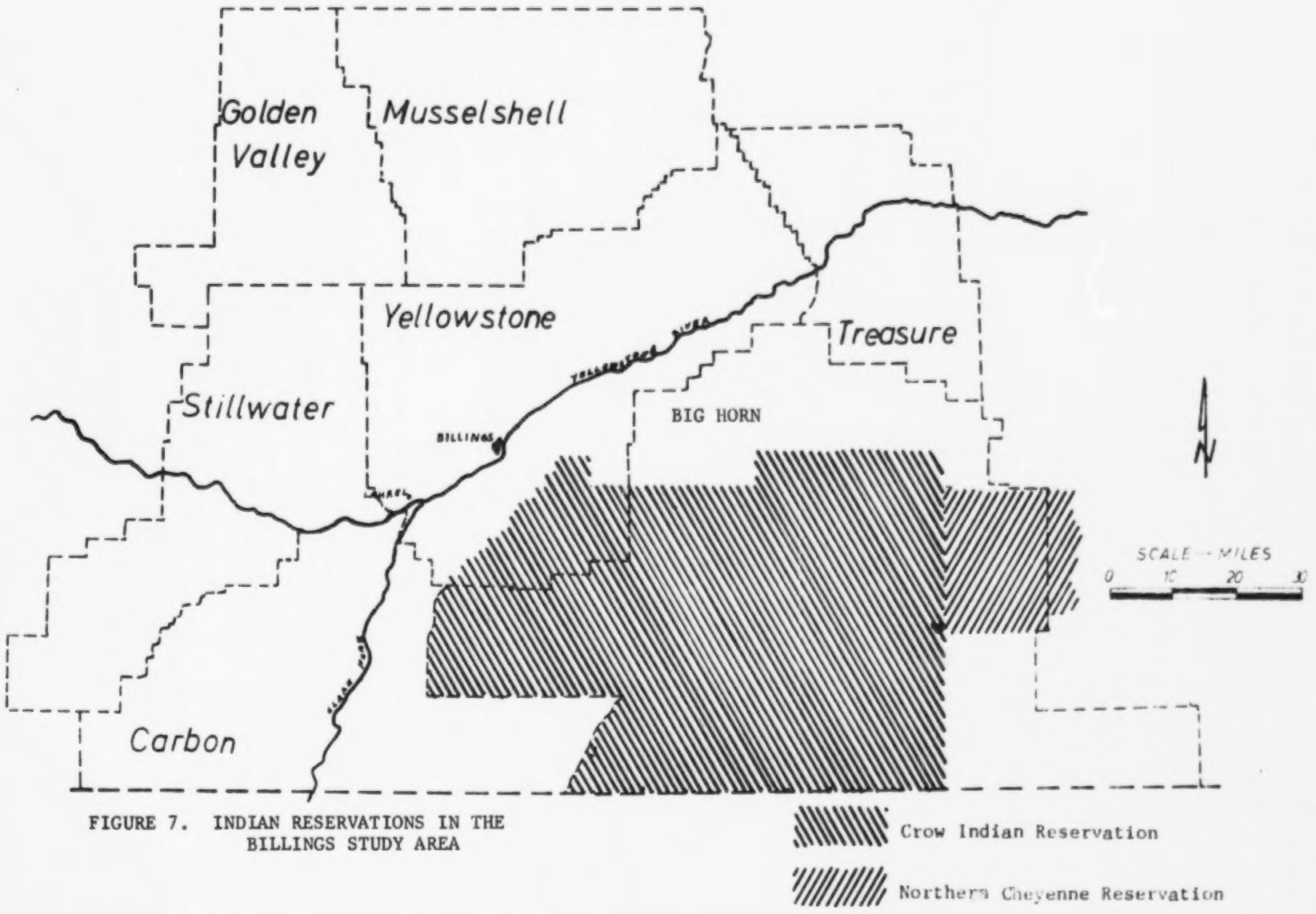

FIGURE 7. INDIAN RESERVATIONS IN THE BILLINGS STUDY AREA

on this reservation numbers about 2,000.

Jurisdictional Considerations

In order to effectively delineate an air quality control region, it is important to consider the existing framework of regional jurisdictions.

The Billings-Yellowstone City-County Planning Board was created by a joint action of the City of Billings and Yellowstone County. The jurisdictional area of the board includes the City of Billings and all land within a 4½ mile radius of its boundary. Presently, the board is engaged in implementing a General Plan that involves promoting a planned growth for the city and suburbs of Billings that will result in a modern, effective, city-urban coalition. Planning is underway for a modern transportation system, expansion of public utilities, control of land use, and many other factors that control the direction of such a large city.

The county of Yellowstone has been named as the Billings Standard Metropolitan Statistical Area (SMSA). The general concept of a metropolitan area is one of an integrated economic and social unit with a recognized large population nucleus. The standard metropolitan statistical area will include the county of a central city, and adjacent counties that are found to be metropolitan in character and economically and socially integrated with the county of the central city.

AIR POLLUTION AGENCIES

State and local programs should be considered in defining boundaries for air quality control regions, since, in the final analysis, the responsibility for implementing regional standards rests with State and local authorities. Existing and proposed legislation should also be considered, because these laws become the basis for legal responsibility and grant enforcement powers to the respective agencies.

The responsiblity for control of air pollution in the State of Montana rests with the State Board of Health. This is set forth in the "Clean Air Act of Montana," enacted in 1967. This Act empowers the State Board to adopt, amend, and repeal rules concerning the Act and to hold air pollution hearings relating to any aspect of the Act. The Board is also granted the power to establish ambient air quality standards for the State as a whole, which it has done. Criteria were adopted on May 27, 1967 for 12 types of pollutants.

The State Board was also given the authority to require permits for construction or alteration of any article that may cause or contribute to air pollution. A set of regulations providing for permits was adopted March 23, 1968. Other powers include emergency procedure, emissions limitations, inspections, penalities, and enforcement. Additionally, under the section dealing with emissions, the Board is given specific power to

set standards in some locations more stringest than Federal standards, if they exist.

There is provision in the State law for establishment of local air pollution agencies. The law states, "Any municipality or county may establish a local air pollution control program upon being petitioned by fifteen per cent of the qualified electors..." This is the authority by which a local program was set up in Yellowstone County.

LOCAL AIR POLLUTION AGENCIES

Under the provisions of the State Law, 15% of the electorate petitioned the City County Health Department to establish an air pollution control program in the County. The Board must enact laws and regulations compatible with or more stringent than those adopted by the State. The Board has enacted a regulation which is as stringest as the State law with similar powers and duties.

The standards include provisions for the control of emissions from open burning, odors, visible sources, sulfur oxides emissions sources, and fuel burning equipment and industrial processes. The regulations provide authority to issue permits, levy fines, grant variances, make inspections, and essentially perform duties similar to those of the State Board of Health which apply on the local level.

This agency has jurisdiction throughout Yellowstone County, including the incorporated areas. Budgeted funds for the first

year included $7,800 non-Federal funds, and $23,400 Federal support in the form of a development grant, for a total of $31,200.

Among the planned activities of the Board is the establishment of a sampling network, total abatement of backyard burning by mid-1971, and establishment of "emergency situation" powers.

Although this Board is only one year old, it already has shown decisive action that has resulted in the abatement of air pollution within its jurisdiction.

THE PROPOSED REGION

Subject to the scheduled consultation, the Secretary, Department of Health, Education, and Welfare, proposes to designate an air quality control region for the Billings area, consisting of the following jurisdictions in the State of Montana.

Carbon County

Stillwater County

Yellowstone County

As proposed, the Metropolitan Billings Intrastate Air Quality Control Region would consist of the territorial area encompassed by the outermost boundaries of the above mentioned counties and the territorial area of all municipalities located therein and as defined in Section 302(f) of the Clean Air Act, as amended, (42 U.S.C. 1857h(f)).

Figure 8 shows the boundaries of the proposed Region.

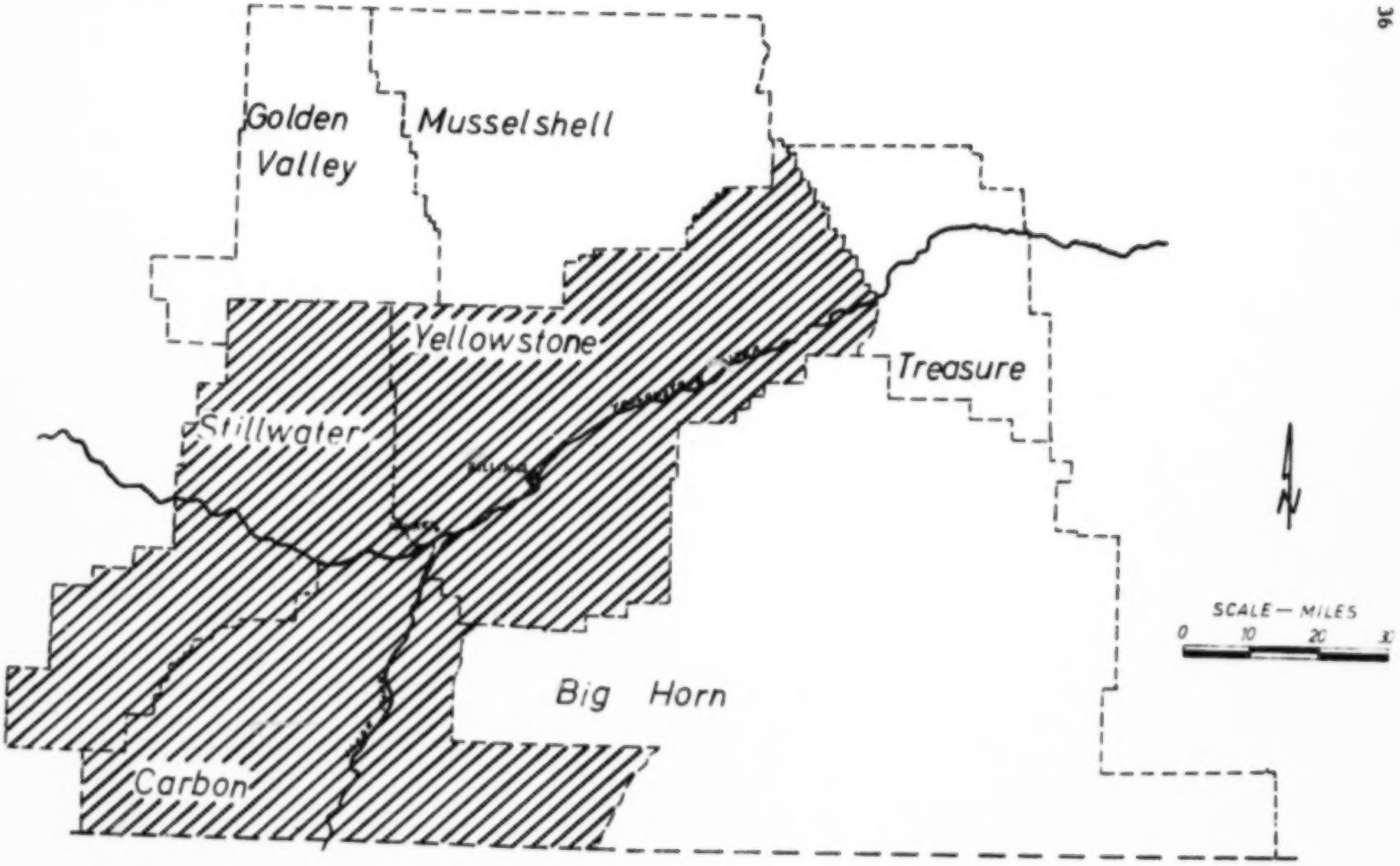

FIGURE 8. PROPOSED BOUNDARIES FOR METROPOLITAN BILLINGS INTRASTATE AIR QUALITY CONTROL REGION

DISCUSSION OF REGION

In order to implement a successful air pollution management program, an air quality control region should be large enough so as to encompass the majority of pollution sources as well as the people and property affected by these sources. Boundaries of the region should also enclose those areas where projected urbanization and industrialization will create problems. Lastly, the boundaries should be compatible with existing regional governmental administration and foster unified and cooperative intergovernmental action. The proposed Billings Region will best satisfy these requirements.

Designating the three counties of Yellowstone, Carbon, and Stillwater, will satisfy the objective that most receptors as well as sources of air pollution in a region be included within the boundaries. Other counties adjacent to these, while they share a common trade and market center, do not significantly share in the air resources common to these three counties. Additionally, the connecting valley systems of the Yellowstone River and Clark Fork create interconnecting channels for atmospheric movements. This would make the three counties part of a contiguous "air shed." In the future, population growth and industrial development will probably be contained within the valley systems. The three county Region will best fit the criteria for future protection of the area's resources.

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